CHANGES IN THE COLLAGEN STRUCTURE OF BONE TISSUE IN EXPERIMENTAL FLUOROSIS

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SUMMARY: The changes in the regularity of collagen structure of the corticalis and spongiosa of rat femur and vertebræ, caused by daily intraperitoneal administration of 0.5 mg and 5 mg sodium fluoride, were investigated. Daily administration of 0.5 mg NaF for three months produced a slight, but significant change in the regularity of collagen fibrils; 5 mg NaF/day, a significant decrease in the regularity and disintegration of collagen fibrils. Alteration in the regularity of collagen fibrils is a part of complex disturbances of the fluorotic bone, explained by the toxic effect of fluoride.

KEY WORDS: Experimental fluorosis; Collagen structure; Disorientation of pre-existing bone.

Introduction

According to experience with humans, about 10% of the entire preexisting bone tissue is reorganized in the course of one year. This perpetual process of rebuilding and remodeling bone tissue is due to the action of multi-cellular functional units (BMU, OBU or OBU), consisting of osteoclasts and osteoblasts. It is generally accepted that sodium fluoride causes enlargement of the whole bone mass.

The question arises how NaF influences bone tissue, whether enlargement of bone mass is due to increased bone formation (stimulation of osteoblasts) (1-7) and/or to decreased bone absorption (blockade of osteoclasts) (5,8-14). Authors agree that newly-formed is inferior to normal bone, the matrix is irregular (1,7,11,15), the collagen structure of newly-formed bone tissue differs from normal (11), and that mineralization is enhanced (1,3,5,7,11,12).

The aim of our experiments was to investigate the changes of collagen structure in experimental fluorosis.

Material and Methods

Forty-five female rats, each weighing 200 grams, were divided into three groups; 15 animals were given 0.5 mg, 15 received 5.0 mg NaF intraperitoneally, daily, for three months; 15 animals - the control group - received physiological saline solution in the same way.

X-ray pictures were taken of the sacrificed animals (Figures 1a, 1b, 1c).

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Table 1

| Retardation of Collagen Fibers in the Corticalis and Spongiosa of Femurs and Vertebrae |
|---------------------------------|---------------------------------|
|                                  | FEMUR                          | VERTEBRA                  |
|                                  | CORTICALIS                     | Spongiosa                 | CORTICALIS | Spongiosa |
| Control                         | 0.7083 ± 0.0240                | 0.6780 ± 0.0304           | 0.6500 ± 0.0281 | 0.6678 ± 0.0393 |
| 0.5 mg NaF                      | 0.6078 ± 0.0281                | 0.5754 ± 0.0513           | 0.6152 ± 0.0298 | 0.5950 ± 0.0230 |
| 5 mg NaF                        | 0.4390 ± 0.0408                | 0.4284 ± 0.0444           | 0.4212 ± 0.0328 | 0.4275 ± 0.0385 |
| Control ∑ 0.6910 ± 0.0332       | 0.5 mg NaF ∑ 0.5981 ± 0.0376   | 5 mg NaF ∑ 0.4275 ± 0.0385 |

The regularity of collagen fibers in the corticalis and spongiosa of femurs and vertebrae decreased compared to normal (Figure 2a) in rats which received 0.5 mg NaF daily. The observed difference is significant (Figure 2b). On rats which received 5 mg NaF daily, for three months, the regularity of collagen fibers decreased significantly compared to normal in the corticalis and spongiosa on both femur and vertebrae (Figure 2c).

Figures 2a, 2b, 2c.

Histologic picture of the diaphysis of femur of a control (a) rat treated daily with 0.5 mg NaF (b), and 5.0 mg NaF (c).
2a: Well differentiated, lamellar bone.
2b: Effect of 0.5 mg NaF collagen structure of preexisting bone tissue slightly disoriented, disintegrated.
2c: Significantly disoriented, disintegrated; effect of 5.0 mg NaF.

The intercellular matrix of bone tissue consists of a collagen structure, embedded in proteoglycan aggregates. The process of formation and mineralization of the intercellular matrix is closely related. Isolated injury of any of these components is inconceivable in injury to one of the components is always associated with injury to the others. During the recent investigation irregularity of collagen structure of preexisting bone tissue could be disclosed by a specific topographic method.

Changes in the Collagen Structure of Bone Tissue in Fluorosis

The investigations disclosed that fluoride causes the regularity of the collagen structure of preexisting, differentiated, lamellar bone to decrease; fluoride exerts its effect not only on the newly generated (newly woven) bone tissue, but it also changes the collagen structure of preexisting bone. In our opinion these changes can be considered part of the toxic effect of fluoride exerted on osteocytes. Changes in collagen structure are followed by damage to the matrix (proteoglycan aggregate). We are planning in future to direct our attention to this field of investigation.

References